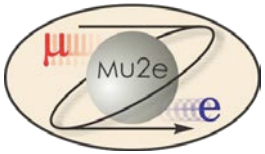
Fermilab



Mu2e CD3c Review
WBS 9.5 TDAQ Controls & Networking

K. Biery

Mu2e TDAQ Controls & Networking L3 Manager

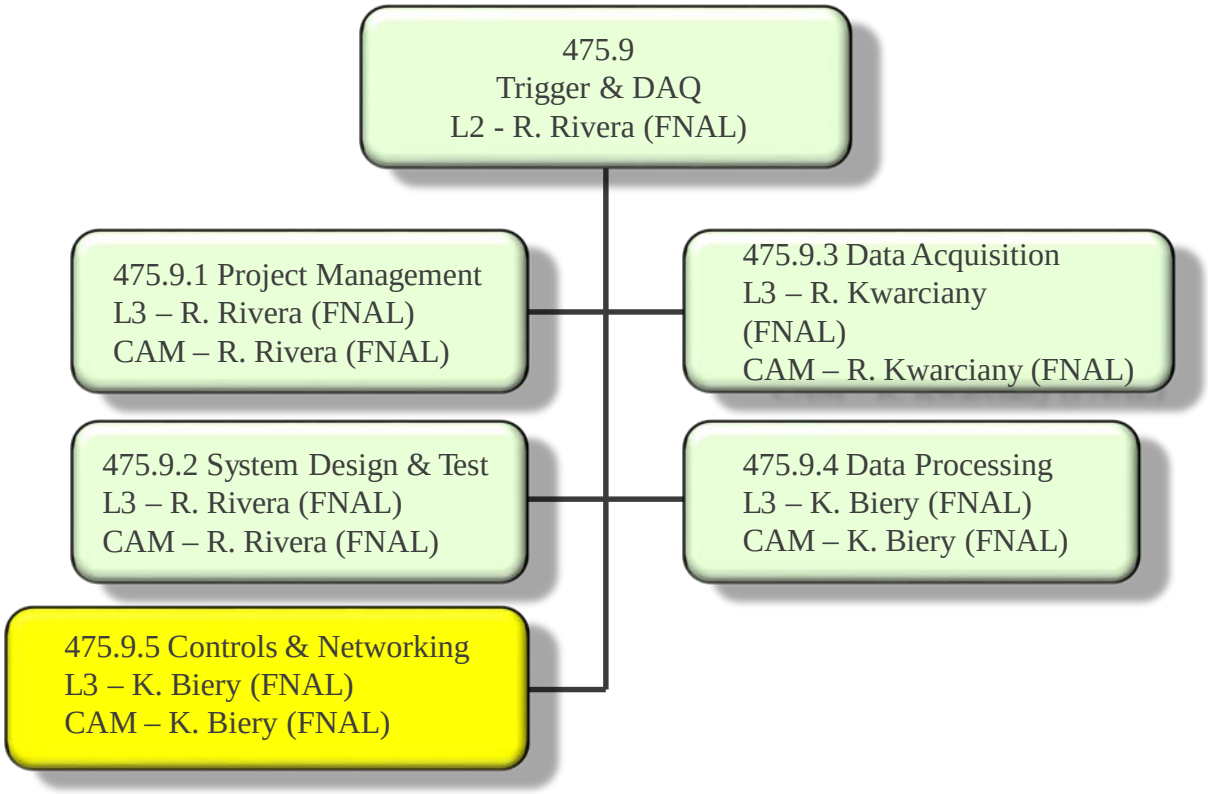
4/20/16

TDAQ Controls & Networking Team

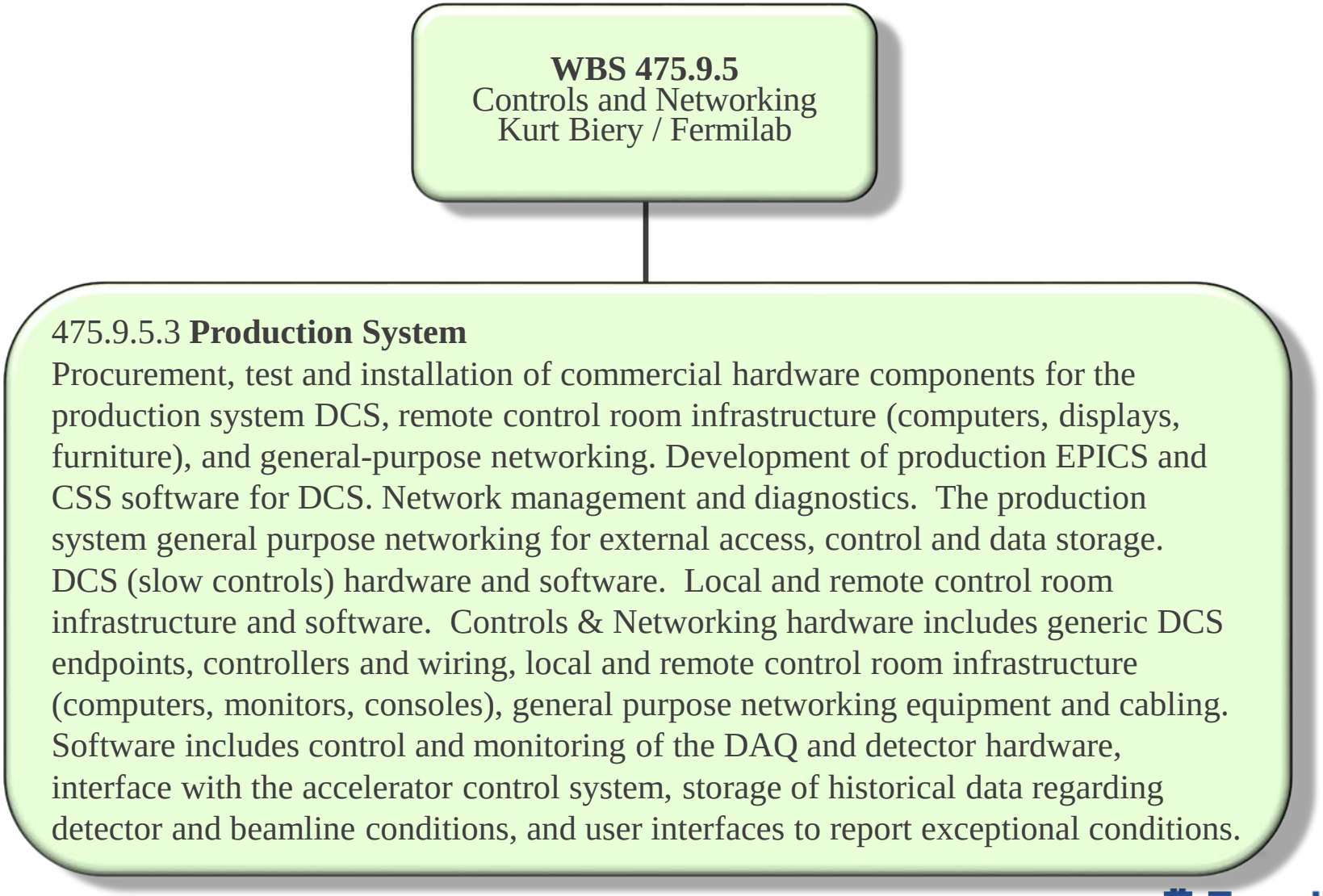
Developed slow controls and networking for MicroBooNE, NOvA. Working on slow controls for SBN…

- Glenn Horton-Smith (Kansas State):
  - EPICS expertise and plans for web-based control and monitoring tools
  - Coordination with sub-detector groups on slow control needs
- Ryan Rivera, Eric Flumerfelt, Ron Rechenmacher, Rick Kwarciany, Mark Bowden (FNAL):
  - EPICS expertise and plans for web-based control and monitoring tools
  - Coordination with sub-detector groups on slow control needs

Mu2e Trigger & DAQ Organization



Scope

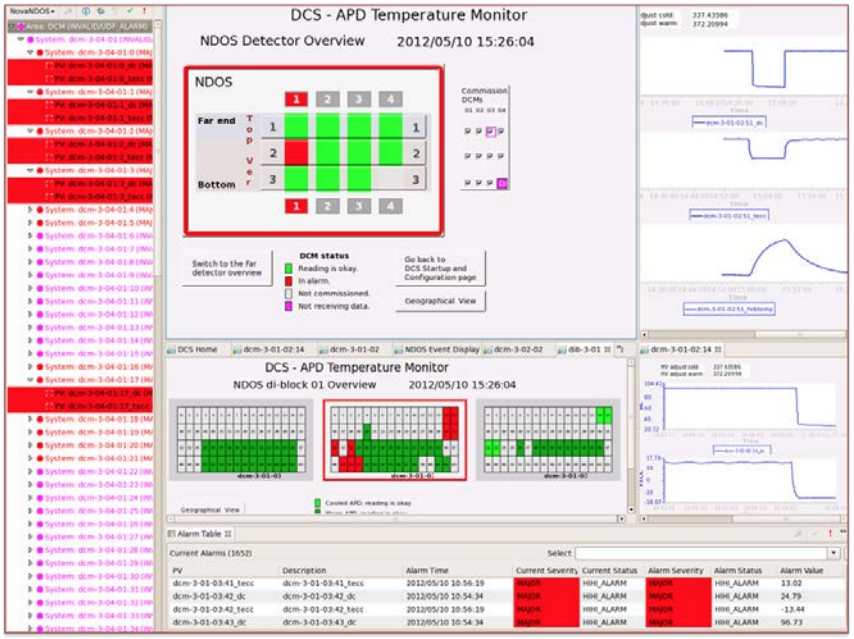

WBS 475.9.5
Controls and Networking
Kurt Biery / Fermilab
475.9.5.3 Production System
Procurement, test and installation of commercial hardware components for the production system DCS, remote control room infrastructure (computers, displays, furniture), and general-purpose networking. Development of production EPICS and CSS software for DCS. Network management and diagnostics. The production system general purpose networking for external access, control and data storage. DCS (slow controls) hardware and software. Local and remote control room infrastructure and software. Controls & Networking hardware includes generic DCS endpoints, controllers and wiring, local and remote control room infrastructure (computers, monitors, consoles), general purpose networking equipment and cabling. Software includes control and monitoring of the DAQ and detector hardware, interface with the accelerator control system, storage of historical data regarding detector and beamline conditions, and user interfaces to report exceptional conditions.

Requirements

- The TDAQ requirements are described in docdb-1150
- The Controls & Networking subsystem must meet the following requirements:
  - Operator-initiated and automatic control of detector subsystems.
  - Simultaneous operations of multiple readout partitions.
  - Collection and stewardship of experiment “slow-control data“ including accelerator configuration and monitoring data. The TDAQ provides the slow-control infrastructure. It does not provide custom sensors or endpoints.
  - Provision for control and status feedback to the accelerator control room and associated accelerator control systems.
  - An online alarm handling system.
  - Computers and networking should be isolated from campus.
  - Mean-time to repair of 1 hour or less and 95% uptime.
  - Transition from warm state to running state within 5 minutes.

Design

- DocDB 3965 has Design and Specification of Detector Control System (DCS, i.e. slow controls)
- EPICS has been selected as the underlying control and monitoring framework.
- Baseline plan is to provide web-based monitoring and alarming.
- Virtual channel over data links to read out DCS data for tracker and calorimeter.
- Data rates in range of 10-20 kbps for each of TRK, CALO, CRV.



Control System Studio control and monitoring GUI from NOvA.

Monitoring Strategy

- The list of known slow control data to be monitored is maintained in Docdb #3965.
- Slow control data accessible by ROCs (i.e. Tracker, Calo, CRV, target monitors) is sent over a virtual channel over the data stream which is routed to the DTC and then across PCIe to the EPICS-based DCS modeled after NOVA and MicroBooNE.
- DCS will provide Ethernet end points in the detector hall for distributed monitoring paths to DCS.
- DCS will provide rack monitoring for 22 racks in electronics room and detector hall.

Monitoring Strategy continued

- Other systems at a glance:
  - ACNET for accelerator components (read-only monitoring)
  - iFIX for Solenoids, Muon Beamline, and fluid controls for Tracker and Calorimeter. (read only monitoring)
  - Johnson Control Metasys for HVAC (DCS ignores)
  - FIRUS for safety systems (DCS ignores)
- DCS gets summary values from the ACNET and iFIX systems (and any other standalone control systems, e.g. Beam Extinction Monitor) as required by the experiment for run conditions or centralized monitoring.
- DCS data will be maintained in a database with a web interface for health and well-being monitoring (e.g. by shifters).

Control Room

Mu2e Remote Control Room - Wilson Hall, 1st floor West

(shared use - LBNF, MicroBooNE, MINERvA, MiniBooNE, MINOS, Muon g-2, Mu2e, NOvA)

Status

- Ongoing discussions with subdetector groups to refine the types and numbers of detector parameters to be monitored and the amount of control to be provided to non-experts.
- Firmware needed to transmit DCS data over a virtual channel on the data links is complete.
- BeagleBone Black testing is ongoing. These inexpensive boards are very promising for some slow controls functions, such as rack monitoring.

DAQ Design Review and Status

- A DAQ Design Review was held on Jan 26, 2016
  - Committee included engineers and physicists/DAQ SW experts
- Committee answered yes to all charge questions.
- Design is 90% complete.
- Primary risk to DAQ is an underestimation of detector rates
  - DAQ has been designed to be flexible, scalable and with significant headroom to mitigate this risk.
- Final report is in mu2e-docdb 6377
  - This includes the recommendations from the committee and our responses.
- There were no recommendations in the areas of Controls and Networking.

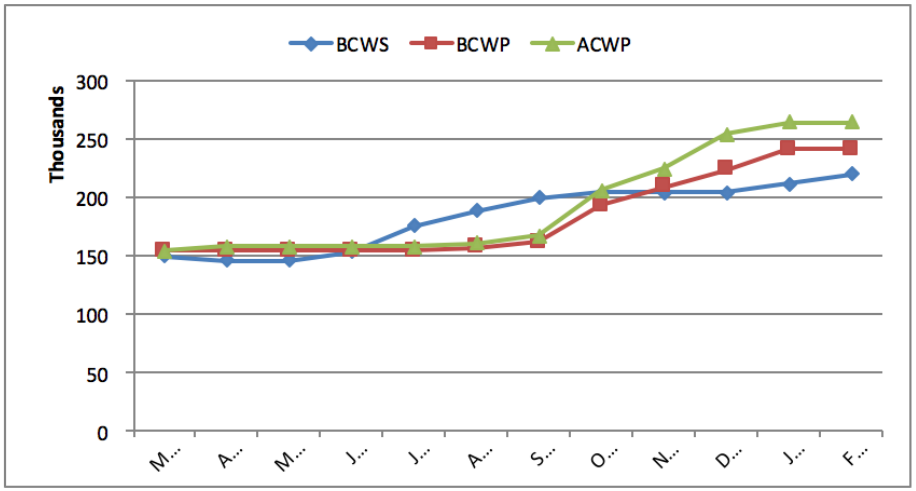
Quality

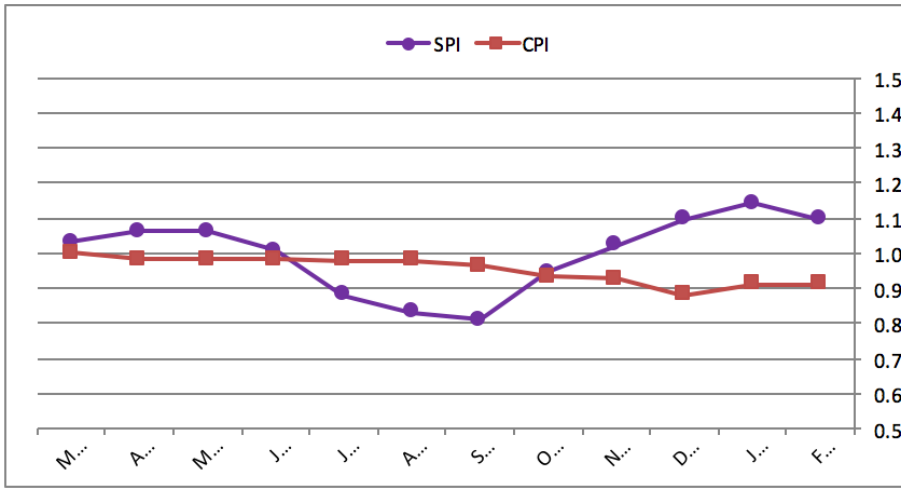
- Data Processing is included in Mu2e Quality Planning Document (DocDB 6005).

Deliverable	QA or QC Step?	QA or QC Process Documentation (DocDB #)	Inspection or Acceptance Criteria/Plan	Verification
Controls and Networking Networking Hardware	Acceptance tests, burn-in tests	Meet or exceed manufacturer's specifications	Incoming inspection, basic power-up functional test	72 hour continuous burn-in test (full rate in six groups of six ports, 12 hours per group, using iperf)
Controls and Networking Slow Controls Hardware	Acceptance tests, burn-in tests	Meet or exceed manufacturer's specifications	Incoming inspection, basic power-up functional test	72 hour continuous burn-in test (self-test, interface loopback software)
Controls and Networking Control Room Hardware	Acceptance tests, burn-in tests	Meet or exceed manufacturer's specifications	Incoming inspection, basic power-up functional test	72 hour continuous burn-in test (standard processor and memory pattern test software)
Controls and Networking Network Management Software	Test with pattern and simulated data	Final Design Report Chapter DocDB #6377	NA	Incremental release testing
Controls and Networking DCS Software	Test with pattern and simulated data	Final Design Report Chapter DocDB #6377	NA	Incremental release testing
Controls and Networking Operator Interface Software	Test with pattern and simulated data	Final Design Report Chapter DocDB #6377	NA	Incremental release testing
Subsystem Equipment that will be meet the Mu2e Requirements as specified in docDB ####	Follow the Integration guidance as specified by the Integration Teams in the Mu2e Grounding Plan, the Mu2e Radiation Testing Plan, the Mu2e Electronics Reliability Testing Plan. Mechanical and Electrical documentation and drawings will be controlled.	Mu2e Grounding Plan (docDB ####), Mu2e Electronics Testing Plan (docDB ####), and Mu2e Electronics Reliability Testing Plan (docDB ####).	Testing will follow Mu2e Integration Team guidelines.	Design satisfy specs before Construction Readiness Review.

Cost and Schedule Performance

475.09.05 Controls and Networking





March 2015 February 2016

- No significant variances.
- Variations in schedule performance simply due to natural variations in when the work is being done.

Cost and Schedule Performance

Report: **Mu2e_Earned Value** - Project Stoplight metrics - Control Account

Project: **Mu2e** - Mu2e Project
Status Date: 02/29/2016

Mu2e Project
February 29, 2016
Currency in: $K

Control Account, Work Package.CTC	Current Period							Cumulative to Date						
	Budget	Earned	Actuals	SV ($)	SV (%)	CV ($)	CV (%)	Budget	Earned	Actuals	SV ($)	SV (%)	CV ($)	CV (%)
475.09.05 Controls and Networking	9	0	0	-9	-100%	0	0%	220	241	264	21	10%	-23	-10%
475.498 475.09.05.01 Controls & Networking Prototype (PED)	0	0	0	0	0%	0	0%	92	92	92	0	0%	0	0%
475.499 475.09.05.02 Controls & Networking Pilot System (Line Item: PE	9	0	0	-9	-100%	0	0%	128	149	172	21	16%	-23	-16%
475.685 475.09.05.03 Controls & Networking Production System (Line Ite	0	0	0	0	0%	0	0%	0	0	0	0	0%	0	0%

Control Account, Work Package.CTC	BAC	EAC	VAC	% Spent	% Complete
475.09.05 Controls and Networking	639	664	-25	40%	38%
475.498 475.09.05.01 Controls & Networking Prototype (PED)	92	92	0	100%	100%
475.499 475.09.05.02 Controls & Networking Pilot System (Line Item: PE	173	197	-24	87%	86%
475.685 475.09.05.03 Controls & Networking Production System (Line Ite	374	375	-1	0%	0%

- No significant variances.
- Work was completed earlier than expected; schedule variance will reduce over the next several months.

Change Control

Control Account	CR #	CR Description	Prior Start	Revised Start	Prior Finish	Revised Finish	Values BAC Before	Values BAC After	Cost Increase / (Decrease)
475.09.05	2	Establish internal baseline and incorporate recommendations from Director's Review.	-	-	-	-	584,621.94	582,685.28	-1,936.66
	6	Corrections made to CR002	-	-	-	-	582,685.28	582,685.64	0.36
	3	New rate adjustments for labor fringe and overhead.	-	-	-	-	582,685.64	580,822.21	-1,863.43
	4	Cost leveling; new CD-3c strategy	-	-	-	-	580,822.21	582,552.81	1,730.60
	8	FY15 Rate changes	-	-	-	-	582,552.81	603,216.66	20,663.86
	12	Solenoids PS and DS Contract terms and Accelerator design reviews	**3/1/13**	3/1/13	**1/21/20**	4/28/20	603,216.66	607,634.27	4,417.61
	15	Establish CD-2 Baseline	**3/1/13**	3/1/13	**4/28/20**	6/29/20	607,634.27	616,603.87	8,969.59
	17	PS/DS Vendor Pay Milestones; Remote Handling Design	**3/1/13**	3/1/13	**6/29/20**	6/29/20	616,603.87	616,863.38	259.51
	18	Detector Bldg Constr Change Order; Argonne Support	**3/1/13**	3/1/13	**6/29/20**	6/9/20	616,863.38	616,452.12	-411.26
	19	Reduced Constr oversight, FFP ECPs, and TS Module fab delay	**3/1/13**	3/1/13	**6/9/20**	6/9/20	616,452.12	616,452.12	0.00
	21	Test Cryostat mods; Upstream pbar window transfer; CRV staff change	**3/1/13**	3/1/13	**6/9/20**	6/24/20	616,452.12	616,777.29	325.18
	22	Detector Bldg. changes; Award TS Module fab; Test Cryostat mods and move	**3/1/13**	3/1/13	**6/24/20**	6/30/20	616,777.29	617,077.17	299.88
	24	FY16 Rate Update	**3/1/13**	3/1/13	**6/30/20**	6/30/20	617,077.17	611,525.17	-5,552.00
	28	Increase Project Office Support, Constr Rev 13, Racks & Rack Monitor	**3/1/13**	3/1/13	**6/30/20**	7/9/20	611,525.17	639,441.84	27,916.67
475.09.05 Total							**8,435,969.93**	**8,490,789.82**	**54,819.90**

- 22 Rack monitors were added in BCR 28.
- The remaining changes were due to changes in other parts of the project.

Interfaces – DocDB 1520

Internal Interfaces			
Item	Interface	Descriptions	Owners
109.04.1.2	IPMI Network	The DAQ servers (475.09.04) connect to the Management Network switch (475.09.05) via dedicated IPMI ports using CAT5e/RJ-45 (1 Gbps) Ethernet	475.09.04 475.09.05
109.05.1.1	Control Room	The Control Room computers (475.09.05) in the Wilson Hall Remote Operations Center connect to the site network via CAT5e/RJ-45 (1 Gbps) Ethernet.	475.09.05 Site Networking
External Interfaces			
109.05.2.1	Mu2e Building	Controls and Networking requires a minimum of 12 square inches of cable routing conduit(s) connecting the upper level electronics room to the lower level detector area. Conduit(s) will carry up to 30 CAT-x5e cables for slow controls.	475.09.05 475.03

Interfaces are understood and under control

Integration

- Discussions at the bi-weekly TDAQ meetings, and dedicated discussions as needed.
- Discussions of grounding and other issues at the Electronics/Integration meeting.

Environmental, Safety, & Health

- ESH is integrated into all phases of the Project
  - Design, Construction, Installation
- ESH requirements are clearly defined within the Project
  - FESHM, FRCM
- L2 hazards & mitigations are captured in the Project HAR
  - High voltage (208 VAC, no exposed connections)
  - Electronic racks
  - Class 1 lasers (eye safe)
  - Slow controls does not have responsibility for any system that involves personnel safety or equipment protection
- Design & installation review process includes an ESH component
- Utilize Fermilab's work planning requirements & processes
  - Hazard analysis

Summary

- The TDAQ Controls & Networking design is 90% complete. Remaining details are in the particular devices and parameters to be monitored and controlled.
- Current design **meets** TDAQ requirements.
- TDAQ Controls & Networking is ready for CD-3 approval.